

NATURAL RESOURCES CONSERVATION SERVICE CONSERVATION PRACTICE STANDARD

TERRACE

(Ft, m)

CODE 600

DEFINITION

An earth embankment, or a combination ridge and channel, constructed across the field slope.

PURPOSE

This practice may be applied as part of a resource management system to reduce soil erosion.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Soil erosion by water is a problem
- The soils and topography are such that terraces can be constructed and farmed with reasonable effort
- A suitable outlet can be provided
- Excess runoff is a problem

CRITERIA

General Criteria

Terraces shall be planned, designed, and constructed to comply with all federal, state, and local laws and regulations.

Spacing. The maximum spacing for terraces for erosion control shall be determined by one of the following methods:

1. $V.I. = xs + y$ or $H.I. = (xs + y) (100/s)$

Where:

V.I. = vertical interval in feet (m)

H.I. = horizontal interval in feet (m)

(See figure 2 and 3)

x = a variable with values from 0.4 to 0.8 (0.12 to 0.24)

s = land slope in percent

y = a variable with values from 1.0 to 4.0 (0.3 to 1.2)

Values of x for different geographical zones are shown in Figure 1. Values of y are influenced by soil erodibility, cropping system and crop management practices. A value of 1.0 (0.3) shall be selected for erodible soils with tillage systems that provide little or no cover during periods of intense rainfall. A value of 4.0 (1.2) shall be used for erosion-resistant soils with tillage systems that leave a large amount of cover (1.5 tons of straw equivalent per acre or 3.4 metric tons per hectare) on the surface. A value of 2.5 (0.75) shall be used if one of the factors indicated is favorable and the other unfavorable. Other values between 1.0 (0.3) and 4.0 (1.2) may be used according to the estimated quality of the factors. The horizontal spacing does not have to be less than 90 feet.

2. Revised Universal Soil Loss Equation

(RUSLE). The spacing shall not exceed the critical slope length as determined using the current version of RUSLE. Soil loss in the inter-terrace interval must be less than or equal to the allowable soil loss.

In no case shall the maximum horizontal spacing exceed that shown in Table 1 for the condition shown. The maximum limits may not be exceeded when making adjustments indicated below.

Spacing may be increased as much as 10 percent to provide better location or alignment,

to adjust for farm machinery, or to reach a satisfactory outlet.

The likelihood of benching of steep slopes by tillage, land forming, and erosion shall be considered when determining the terrace interval. For example, use the proposed as-built slope and length in RUSLE calculations.

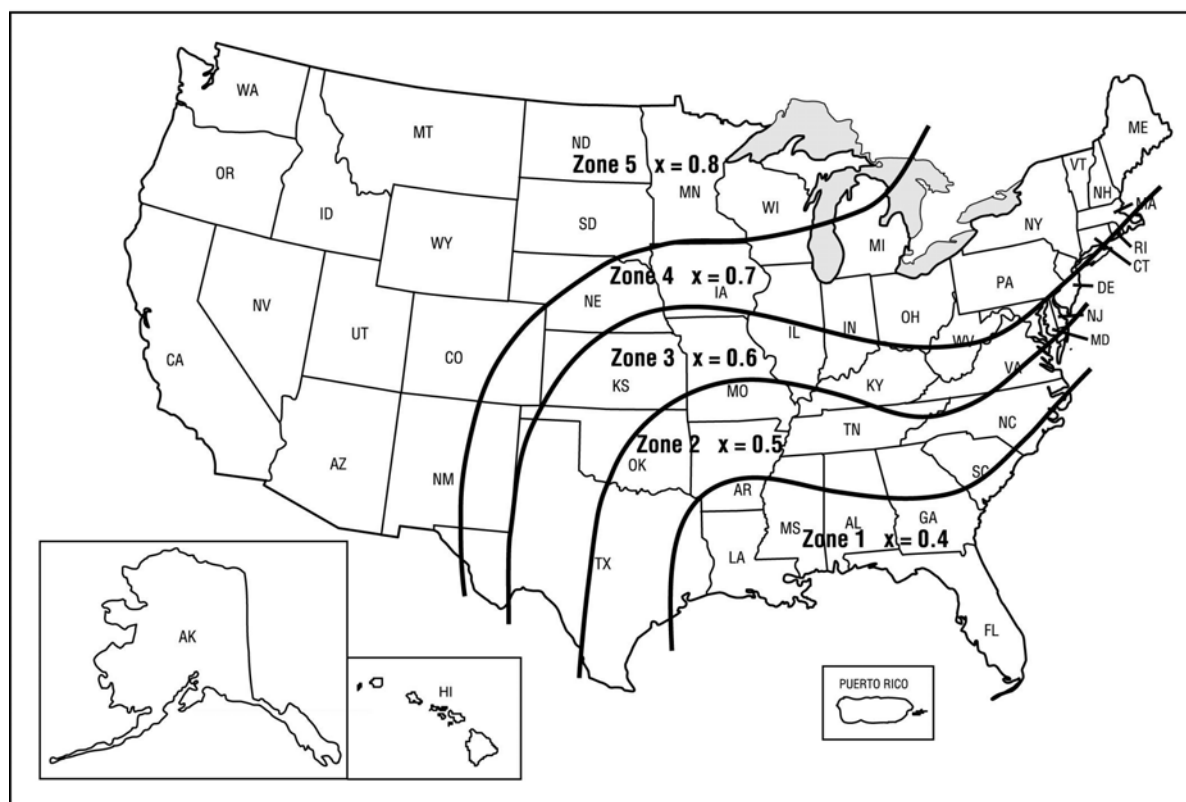


Figure 1. Values of x in equation $V.I. = xs + y$ or $H.I. = (xs + y) (100/s)$ (English Units)

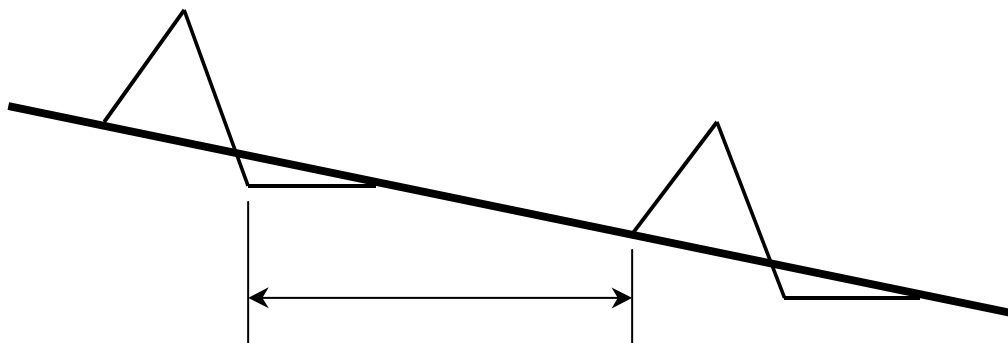


Figure 2. Horizontal Interval for Steep Back-slope Terraces

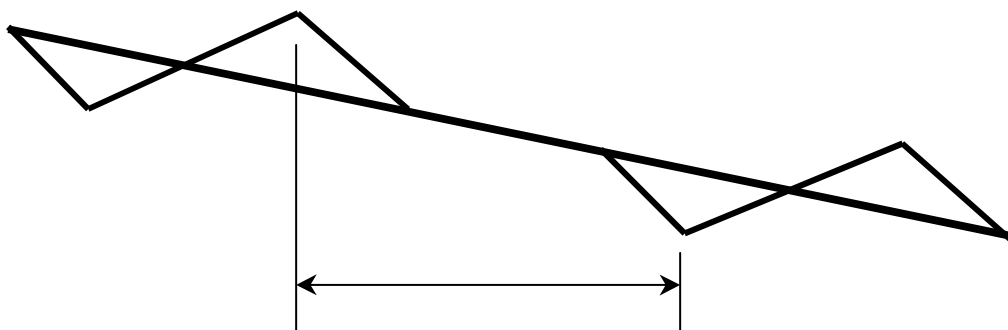


Figure 3. Horizontal Interval for Broad-Based Terraces

Table 1. Maximum horizontal spacing for terraces

Percent Slope	Ft	M
0-4	700	210
4-6	600	180
6-12	400	120
12-18	250	75
> 18	250	75

Alignment. Cropland terraces shall be parallel if feasible and as parallel as practicable. Curves shall be long and gentle to accommodate farm machinery.

Capacity. The terrace shall have enough capacity to control the runoff from a 10-year frequency, 24-hour storm without overtopping. For terraces with underground outlets, the capacity shall be increased by the estimated 10-year sediment accumulation, unless sediment is removed through maintenance. Terrace systems designed to provide flood protection or to function with other structures shall have the appropriate design capacity. When the capacity is determined by the formula $Q = AV$ and the V is calculated using Manning's formula, a minimum n value of 0.035 shall be used for bare channels. Agricultural Handbook Number 667, Stability Design of Grass-lined Open Channels, or equivalent shall be used for vegetated channels.

Cross section. The terrace cross section shall be proportioned to fit the land slope, the crops grown, and the farm machinery used. Additional height shall be added if necessary to provide for settlement, channel sediment deposits, ridge erosion, the effect of normal tillage operations, and safety. The ridge shall have a minimum width of 3 ft. (1 m) at the design elevation. The steepest slope of a vegetated front or back ridge slope is 2 horizontal:1 vertical. Terrace ridges, especially those with steep back slopes, can be very hazardous. All cropped terrace slopes that are to be farmed shall be no steeper than those on which farm equipment can operate safely. Potential hazards must be brought to the attention of the responsible person. The opening at the outlet end of gradient terraces shall have a cross section equal to that specified for the terrace channel.

Channel grade. Channel grade shall be determined by one of the following methods:

1. Maximum channel velocities for permanently vegetated channels shall not exceed those specified for grassed waterways (practice standard 412).
2. Maximum channel velocity for cultivated channels shall be nonerosive for the soil and

planned treatment. Maximum velocity for erosion-resistant soils is 2.5 ft/s (0.75 m/s); for average soils, 2.0 ft/s (0.6 m/s); and for easily erodible soils, 1.5 ft/s (0.45 m/s). Velocity shall be computed by Manning's formula, using a maximum n value of 0.035.

For short distances and in upper reaches, channel grades or velocities may be increased to improve alignment. If terraces have an underground outlet, water and sediment will pond in the lower reaches of the channel, thus reducing the velocity in those reaches and allowing steeper channel grades within the impoundment area. Minimum grades shall be such that ponding in the channel caused by minor irregularities will not cause serious damage to crops or delay field operations.

Terrace length. Normally, the capacity and the nonerosive velocity requirements will control the gradient terrace length.

Outlets. All terraces must have adequate outlets.

Vegetated outlets may be used for terraces. Such an outlet may be a grassed waterway or other vegetated area. The outlet must convey runoff water to a point where the outflow will not cause damage. Outlets shall be installed and vegetation established before the terrace is constructed to provide a stable outlet. The water surface in the terrace shall not be lower than the water surface in the outlet at their junction when both are operating at design flow.

Underground outlets may be used on terraces. The outlet consists of an intake and an underground conduit. An orifice plate, increase in conduit size, or other features shall be installed as needed to control the release rate and prevent excessive pressure in the conduit. Terraces shall be designed to control a 10 year frequency, 24-hour storm without overtopping. The release time shall not exceed 48 hours for the design storm. Shorter periods may be necessary for some crops, depending on soils characteristics and water tolerance of crops to be grown. If sediment retention is desired, adjust release rate according to particle size.

The underground conduit shall meet the requirements specified for Underground

Outlets (620) or Subsurface Drains (606). Conduits must be installed deep enough to prevent damage from tillage equipment. The inlet shall consist of a vertical perforated pipe or other structure suitable for the intended purpose. The inlet shall be located uphill of the front slope of the terrace ridge, if farmed, to permit passage of farm machinery and, if necessary, provide for the anticipated accumulation of sediment. The outlet of the conduit shall have adequate capacity for the design flow without causing erosion. Blind inlets may be used where they are effective.

Combinations of different types of outlets may be used on the same system to affect water quality, and to provide for economical installation of a more farmable system.

Vegetation. All areas to be vegetated shall be established as soon as practicable after construction.

Drainage. Install subsurface drainage to stabilize terrace where needed.

CONSIDERATIONS

Consider adjusting the spacing to allow an even number of trips with the equipment.

Consider aligning terraces and/or installing subsurface drainage to correct seepage problems.

Potential for development of saline seeps or other salinity problems may result from increased infiltration in soils that have restrictive layers.

Potential for uncovering or redistributing toxic materials such as saline soils may result during construction.

PLANS AND SPECIFICATIONS

Plans and specifications for installing terraces shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be prepared for the operator.

The minimum requirements to be addressed in the operation and maintenance plan are:

1. Provide periodic inspections, especially immediately following runoff events.
2. Promptly repair or replace damaged components as necessary.
3. Maintain terrace ridge height and outlet elevations.
4. Remove sediment that has accumulated in the terrace to maintain capacity and a positive channel grade.
5. Each inlet for underground outlets must be kept clean and sediment buildup redistributed so that the inlet is in the lowest place. Inlets damaged or cut off by farm machinery must be replaced or repaired immediately.
6. Vegetation, where specified, shall be maintained and trees and brush controlled by chemical or mechanical means.
7. Vegetated outlets should be established before construction when feasible.
8. Keep machinery away from steep back sloped terraces. Keep equipment operators informed of all potential hazards.

CONSTRUCTION

All dead furrows, ditches, or gullies shall be filled before constructing the terrace or shall be part of the construction. All old terraces, fence rows, hedge rows, trees, and other obstructions shall be removed, as necessary, to install a farmable system.

The terraces shall be constructed according to planned alignment, grade and cross section with the specified overfill for settlement and the channel graded to drain reasonably well.

Any ditch or depression at the bottom of the back slope shall be filled and smoothed so that drainage will be away from the terrace and not parallel to it.

Provisions must be made to prevent piping if underground circuits are located under terrace ridges. Mechanical compaction, water packing, trench sidewall sloping, and installation and backfill of conduit trenches early enough to allow adequate settlement are methods that can be used. The materials used

for the inlet and the conduit shall be suitable for the purpose intended (see standard 606). Terrace ridges constructed across gullies or depressions shall be compacted by machinery travel or by other suitable means to insure proper functioning of the terrace.

The surface of the finished terrace shall be reasonably smooth and present a workmanlike finish.

If necessary, topsoil shall be stockpiled and spread over excavations and other areas to facilitate restoration of productivity.

If vegetation is required, seedbed preparation, fertilizing, seeding, and mulching shall comply with specifications in technical guide practice standard 342, critical Area Planting.